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USSR SCREW-CUTTING LATHES AND VERTICAL BORING MILLS

The extensive development of high-speed machining methods and of high-quality domestic hard alloys, types T5K10, T15K6, T30K4, VK8, VK6, and VK3 has brought about a rapid increase in the speed and power of metal-cutting machine tools.

For purposes of comparison, Table 1 shows the average cutting speeds and power used in lathe operations for machining different grades of steel with hard-alloy cutters and with high-speed-steel cutters, with the depth of cut t = 2 millimeters, and feed s = 0.5 millimeter per revolution.

Table 1

	Cutters	Steel Being Machined		
		35	45	60
Cutting speed, m/min	Hard alloy	195	162	128
	High-speed steel	26	21	15
Power speed, m/min	Hard alloy	7.6	7	6.4
	High-speed steel	1.31	1.15	0.89

It is clear from the above table that in turning steel 35, the cutting speed, with the use of a hard-alloy tool [as compared with a high-speed-steel tool], increases 3-7.5 times, whereas in turning steel 60, it increases 8.6 times; that is, the tougher the material being machined, the greater the increase in cutting speeds. A similar situation occurs in regard to the power.

Table 2 shows the cutting conditions for turning steel 60 with hard-alloy and high-speed-steel cutting tools for a duration of 240 minutes.

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Table 2

Feed (mm/rev)	Cutters	Cutting Speeds, m/min With the Depth of Cut in Millimeters				
		0.5mm	1mm	2mm	4mm	8mm
0.1	Hard-alloy	310	300	325		
	High-speed steel	32.5	31.5	29.5		
0.16	Hard-alloy	275	250	240		
	High-speed steel	32.5	30	28.5		
0.25	Hard-alloy	260	225	200	185	
	High-speed steel	30.5	29	27.5	25	
0.5	Hard-alloy		160	143	133	128
	High-speed steel		27	25	23	20
1.0	Hard-alloy			110	101	98
	High-speed steel			20.5	18	16

The table indicates that with a decrease in the amount of feed, the cutting speed increases sharply. For example, with a feed of one millimeter per revolution, the speed of hard-alloy cutters is 5.5 times the speed of high-speed-steel cutters; and with a feed of 0.1 millimeter per revolution, 9.5 times.

Thus the use of hard-alloy cutting tools requires a considerable increase in machine-tool power and speed; this is verified by the data given in Table 3.

Table 3

Cutting Conditions in Machining Steel, σ_b = 70 kg/sq mm With Hard-Alloy and High-Speed-Steel Cutting Tools

Depth (mm)	Feed (mm/rev)	Cutting Tools	Cutting Speed (m/min)	Power (kw)
2	0.5	High-speed steel	25	1.2
		Hard-alloy	140	5.8
4	1.	High-speed steel	18	2.5
		Hard-alloy	100	17

In the following account, the terms "roughing" and "finishing" will be used; they are relative and depend on the type of production; for example, at instrument-building plants, roughing operations correspond to finishing operations at medium machine-building plants.

Table 4 gives the limits which define the concept of rough, semifinish, and finish machining in medium machine building.

[redacted]

Table 4

Type of Machining		Rough	Semifinish	Finish
Depth of cut, mm		> 5	2-5	< 2
Feed, mm/rev		> 0.4	0.2-0.4	< 0.2
Cross section, mm^2		> 2	0.4-2	< 0.4
Required power, kw	High-speed-steel cutters	> 2	0.5-2	< 0.5
	Hard-alloy cutters	> 12	4-12	< 4

From this table it is clear that a chip with a cross section of one square millimeter (t= 2 mm, s = 0.5 mm/rev falls within the category of semifinishing.

If steels 35, 45, and 60 are machined with hard-alloy cutters at t = 2 millimeters and s = 0.5 millimeter per revolution, the power of the machine tool must be 6.4-7.6 kilowatts; for a rough chip 5 square meters in cross section, the power must be 20 kilowatts.

Figure 1 [appended] shows the approximate increase in cutting speed and power in machinery steel σ_b = 70 kilograms per square millimeter depending on the type of cutters used; for example, in machining with a high-speed-steel cutter, the cutting speed, feed, and power correspond to Area A; cutters with tungsten carbide blades, Area B; and with tungsten-titanium-cobalt, Area C.

Changes in technical specifications of lathes can be seen from Table 5.

[Table follows on next page.]

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Table 5

Table of Comparison of
Technical Specifications of Old and New Machine Tools

Model No	Year of Release	Diameter of Work Over Bed and Distance Between Centers, mm	No of Spindle Seeds	Range of Speeds, rpm From	To	% of Increase of Max Speed	No of Feeds	Range of Feeds, mm/rev From	To	Power Kw	% of Increase	Weight Kg	% of Increase	Ratio of Weight to Power, kg/kw
1615	1933	320x750	8	26	492	--	40	0.06	2.73	1.5	--	850	--	565
1615M	1948	320x750	8	44	1,000	103	40	0.06	2.7	2.2	47	980	11	445
1616	1949	320x750	12	44	1,980	302	70	0.06	2.4	4.3	185	1,900	122	440
1D62	1932	400x1000	18	12	600	--		0.12	2.15	3.5	--	1,600	--	450
1A62	1949	400x1000	24	11.5	1,200	100	35	0.08	1.59	7.8	100	2,200	38	280
1620	1950	400x1000	Infinitely variable	18	3,000	400		0.05	2.0	13.0	270	3,700	130	280
1D63	1933	615x1500	18	9.6	480	--		0.15	2.65	6.8	--	3,450		500
1D63A	1950	615x1500	18	24	750	56				10	46	3,450		345
1D64	1934	800x3000	12	8	362	--		0.22	3.14	11		6,650		600
164	1950	800x3000		7.5	750	100				22	100	1,400	110	640

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Model 1616 screw-cutting lathe [schematic drawing available in source in CIA] makes possible the full utilization of hard-alloy tools in finish machining of steel and partial utilization in machining nonferrous and light metals. Semi-finishing and light roughing operations can be performed on it.

Full utilization of hard-alloy cutting tools in machining nonferrous and light metals requires the application of high cutting speeds; in rough machining of steel blanks with maximum depth of cut and feed, high power is required.

The meeting of these requirements in universal machine tools is technically difficult and leads to excessive complexity and cost of the machine tool. It is more expedient to design and manufacture machine tools of a more simple design.

An automatic lathe [photograph available in source in CIA; model number is not given] with a power of 24 kilowatts is intended for machining graduated shafts with hard-alloy cutters according to a former with the use of an electric tracer. In size, it corresponds to Model 1D62.

The power of Model 1616 is three times as great as the power of its predecessor, Model 1615, and its speed is four times as great.

The special design features of Model 1616 are (a) a rigid bed mounted on an ordinary base; (b) a "razdelennyy" spindle drive from the gear box with the possibility of using a mechanical variable gear or another drive; (c) a bracket-type arrangement of the driving V-belt pulley; (d) a tapered spindle nose which eliminates the self-unscrewing of the chuck; (e) an enclosed feed box with convenient control; (f) an apron of improved design permitting operation up to the stops; (g) mechanized carriage travel with convenient control and large-diameter dials; and (h) attractive external design.

This machine tool is produced in two modifications; Model 1616 with normal accuracy and Model 1616P with increased accuracy.

Another type-size of a screw-cutting lathe is Model 1620. This machine tool has a "razdelennyy" smoothly adjusting spindle drive from a variable gear, with mechanical synchronization of the clutches and gears at the moment of shifting. A special mechanism with a drum is used for changing speed. The latter is actuated by a separate electric motor through a V-belt drive and two worm pairs. This mechanism permits the selection of any spindle speed by pressing a button.

The new shape of the spindle nose eliminates the self-unscrewing of the faceplate. [Schematic drawings and more detailed description of Models 1620 and 1A62 are available in source.]

Model 164 heavy screw-cutting lathe is being manufactured in place of Model 1D64. [Schematic drawing of kinematic system of Model 164 is available in source in CIA.] Machine tool drive is from a separate electric motor through a V-belt transmission and gear box.

The shifting of spindle speeds is done hydromechanically with a speed preselector. The spindle is supported in the front and rear by double-row cylindrical roller bearings with tapered internal holes and in the center by a single-row roller bearing. The axial load is absorbed by two radial thrust bearings.

The universal feedbox is of the enclosed type. It permits the cutting of any type of thread without changing gears. The shifting process is simplified because it is controlled by a minimum number of levers and by an ocular device.

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The compound slide has rapid mechanized movements in any direction from a separate electric motor with convenient control by means of a lever.

The apron is equipped with four electromagnetic clutches for independent engagement and reversal of the longitudinal and transverse feeds. Not only can the machine tool semiautomatically do form-turning according to a former or a model; but it can also machine graduated shafts with the use of lathe dogs. The tailstock has a built-in live center.

The basic specifications of universal lathes being produced at present are making possible the utilization of hard-alloy tools; however, there are insufficient grounds for certain basic specifications and for the degree of automatization. This leads to excessive complexity and cost of machine tools.

For example, it is positively unwise to accept the wide range of spindle speed adjustment. The top spindle speed of 3,000 revolutions per minute is too high.

It must be noted that new machine tools are being developed on the basis of different design systems without using methods of unification and comparison. Thus, the prewar experience of designing unified machine tools for the Izhevsk Plant, as well as the method of planning similar machine-tool designs with a swing of 200, 300, and sometimes 400 millimeters at the Krasnyy Proletariy Plant are not being used.

In the future, universal unified screw-cutting lathes must be developed in the normal course of events and on the basis of these, automatics must also be developed. This procedure will make it possible to design inexpensive and reliable machine tools.

The impression that a universal machine tool is a machine intended for use in series production must be changed. Such machine tools are being used in series-producing shops at present because of a shortage of high-duty multitool machine tools and quick retooling semiautomatic lathes which can utilize completely the cutting properties of hard-alloy tools. These types of machine tools must be built.

In addition to normal universal machine tools, simplified lathes must be produced for the MTS, kolkhoz workshops, etc.

A number of modern high-duty double-sided vertical boring and turning mills were perfected in 1950. A short list of specifications of these machine tools is given in Table 6.

Table 6

	Machine Tool Model Numbers				
	1551	1551V	1553	1556	157
Maximum workpiece diameter, mm	1,500	1,500	2,100	2,500	7,000
Weight of workpiece, tons	5.0	1.0	6.0	14.0	150
Range of faceplate speeds, rpm	3-96	11-300	2.2-71.6	0.95-47.5	0.19-12
Power of main drive electric motor, kw	28	37	37-40	37-40	120
Weight, tons	21.0	23.0	35.0	42.0	350

/Photographs of Models 1551 and 1556, and schematic drawings of Model 1551 are available in source. Photograph of Model 1553 is available in CIA in Stanki i Instrument, Oct 1950, front cover./

The design of these machine tools permits the utilization of hard-alloy tools. Their operation has been mechanized to a considerable degree.

The following operations can be performed on Model 1551 vertical boring mill: turning and boring of cylindrical, tapered, and irregularly-shaped surfaces; facing and thread-cutting; and with the use of a revolving head, drilling, counterboring, and reaming. The faceplate is driven by a single-speed three-phase 28-kw electric motor which is connected to a 16-stage gear box.

Model 1551V double-sided machine tool of the same type-size is intended for machining items made of light alloys. It differs from Model 1551 by its high spindle speeds which reach up to 300 revolutions per minute, while the feed per faceplate revolution is 4.5 times less than that of Model 1551.

Model 1553 is a second type-size of vertical doubled-sided boring mill. Its design is similar to Model 1551.

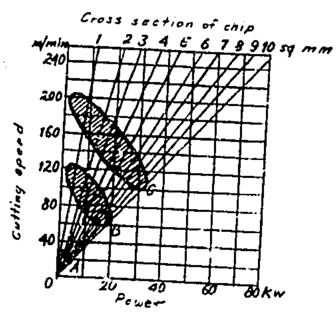
A wide unification has taken place between Models 1551 and 1553. Model 1551 has 795 nonunified parts and 581 unified; Model 1553 has only 159 nonunified and 1,181 unified; that is, 88 percent have been unified. Such a high degree of unification greatly accelerates machine-tool output.

Double-sided vertical boring mill Model 1556 is intended for machining items up to 14 tons in weight and 2,500 millimeters in diameter. It is a third type-size. It has remote control and enough interlocks to protect it from breakdown.

A unique doubled-sided vertical boring mill, Model 157, is intended for machining items up to 150 tons in weight, 7,000 millimeters in diameter, and 4,000 millimeters high. It has 14 electric motors with a total power of 200 kilowatts.

In addition to the above-described double-sided vertical boring mills, machine tools have been designed to machine items up to 3,200, 4,000 and 5,000 millimeters in diameter.

[Appended figure follows.]



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